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The effects on cow performance and calf birth and weaning weight of replacing grass silage with brewers grains in a barley straw diet offered to pregnant beef cows of two different breeds

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Keywords ruminants, nutrition, protein, energy

Running head: Nutritional responses of spring-calving beef cows

Summary

The effects on cow and calf performance of replacing grass silage with brewers grains in diets based on barley straw and fed to pregnant beef cows are reported. Using a 2 x 2 factorial arrangement of breed and diet, cows pregnant by artificial insemination (n=34) of two breeds (crossbred Limousin, n=19 and pure-bred Luing, n=15) were fed diets *ad libitum* which consisted of either (g/kg dry matter) barley straw (664) and grass silage (325; GS) or barley straw (783) and brewers grains (206, BG) and offered as total mixed rations. From gestation day (GD) 168 until 266, individual daily feed intakes were recorded and cow body-weight (BW) and body condition score (BCS) measured weekly. Calving date, calf sex, birth and weaning BW, and calf age at weaning were also recorded. Between GD 168 and 266, crossbred Limousin cows gained more weight than Luing cows ($p < 0.05$) and cows offered BG gained more weight than cows offered GS ($p < 0.001$). Luing cows lost more BCS than crossbred Limousin cows ($p < 0.05$) but diet did not affect BCS. There were no differences in dry matter intake as a result of breed or diet. Calf birth BW however, was greater for cows fed BG than GS (44 v 38 kg, SEM 1.0, $p < 0.001$) with no difference between breeds. At weaning, calves born to BG-fed cows were heavier than those born to GS-fed cows (330 v 286 kg, SEM 9.3, $p < 0.01$). In conclusion, replacement of grass silage with brewers grains improved the performance of beef cows and increased calf birth and weaning BW. Further analysis indicated that the superior performance of cows offered the BG diet was most likely due to increases in protein supply which may have improved both energy and protein supply to the foetus.

Keywords pregnancy, nutrition, protein

Introduction

Production systems for spring-calving beef cows rely on matching peak nutrient requirements for lactation with optimum availability of nutrients from grazing in spring and summer (Phillips, 2001). During summer, the cow is also able to replenish body energy (fat) reserves mobilized during winter. In these low input systems, feed nutrients during winter are usually supplied from standing dormant herbage or, if the cows are housed, diets include substantial proportions of low digestibility forage such as barley straw. Thus, the energy supply during pregnancy is less than requirement and thus the cow mobilises body reserves to meet the demands of the foetus. Most reviews upon under-supply of nutrients to the pregnant cow have concluded that only severe and chronic under-nutrition, particularly during the final two-thirds of the 280 day bovine pregnancy, has a negative effect on calf birth body-weight (BW, Holland and Odde 1992; Greenwood and Cafe 2007). Further, an energy deficiency is more important than a protein deficiency, although the composition of absorbed nutrients may be important (Radunz et al. 2010). Reductions in calf birth BW have implications not only for pre-weaning mortality (Wu et al. 2006) but are also frequently associated with reduced BW at weaning (Cafe et al. 2006; Stalker et al. 2006) and this may have consequences for subsequent fertility (Martin et al. 2007), carcass yield and quality (Greenwood and Cafe 2007) and therefore enterprise profitability (Miller et al, 2001; Quality Meat Scotland 2014).

Most recent nutritional studies on pregnant beef cows have been within systems where cows were maintained on pasture (e.g. Cafe et al. 2006; Larson et al. 2009) and therefore detailed information on individual maternal feed intakes and changes in maternal BW and body condition score (BCS) is only rarely available

(Martin et al. 2007; Klein et al. 2014). Further, genotypes of beef cow have changed, for example, with the introduction of breeds such as the Luing, since current feeding systems for beef cows were last revised (AFRC, 1993). In this study, two different diets in which brewers grains replaced grass silage in a conventional low energy grass silage / barley straw diet were fed to cows of two different breeds (during mid and late pregnancy. Detailed information on individual cow feed intake, BW and BCS and calf birth and weaning BW were recorded. The experimental hypothesis tested was that the breed of the cow would influence cow performance and have consequences for calf birth and weaning BW. Methane emissions from this study have been reported elsewhere (Duthie et al., 2015).

Materials and methods

Animals, experimental design and diets

This study was conducted at the Beef Research Centre of SRUC (6 miles south of Edinburgh, UK) in winter 2011 - 2012. The experiment was approved by the Animal Experiment Committee of SRUC and was conducted in accordance with the requirements of the UK Animals (Scientific Procedures) Act 1986.

The cows used were part of a larger group (n=48; Duthie et al., 2015) and ranged from 3 to 13 years in age and which consisted of equal numbers (n=24) of each of two breeds (crossbred Limousin and pure-bred Luing) which were allocated to two diets according to a 2 x 2 (breed x diet) factorial design which was within groups (n=12) balanced for cow BW and age. The cows used in this study (n=34) were those confirmed pregnant to synchronised artificial insemination on 20 June 2011, with 14 cows not pregnant to this artificial insemination omitted from the dataset. This ensured that experimental observations were not biased by differences in stage of pregnancy. The accuracy of pregnancy diagnosis was confirmed from actual calving dates. On gestation day (GD) 148 (15 November 2011), the cows were allocated to the two experimental diets and housed in a group in one pen per diet. The diets were fed using electronic feeders (n=16 per pen; HOKO, Insentec, Marknesse, the Netherlands) and individual daily feed intakes recorded. The cows were acclimatized to the pen environment and trained to use feeders until GD 168 (5 December 2011) when records of daily feed intake began. Cow BW (kg) and BCS (using a scale of 1 to 5, Lowman et al. 1976) were measured weekly until observations were completed on GD 266 (12 March 2012) when cows were returned to standard farm management. Calving date, calf sex, birth and weaning BW and age at weaning were subsequently recorded. The two experimental diets consisted (g/kg dry matter, DM) of barley straw (664) and grass silage (325, GS) or barley straw (783) and brewers grains (206, BG) which were offered as total mixed rations on an *ad libitum* basis. The ingredient and chemical compositions of the diets are given in Table 1 and chemical composition of the feeding stuffs is given in Table 2.

Feed analysis

Dry matter contents of the feeding stuffs were determined twice weekly and bulked feed samples (three per feeding stuff) analysed for DM, ash, crude protein, acid detergent fibre, neutral detergent fibre and starch according to Ministry of Agriculture Fisheries and Food (1992).

Calculations and statistical analysis

Daily DM intakes (DMI) were averaged on a weekly basis prior to analysis. Changes in cow BW, BCS and DMI together with data for gestation length and calf birth and weaning BW were analysed using general linear models regression (Genstat Version 15.1, Lawes Agricultural Trust, 2012) according to a 2 x 2 arrangement of breed and diet. Cow BW and BCS at allocation (GD 148) were included as covariates in analysis of cow BW or BCS where significant ($p < 0.05$); calf sex, birth BW and age at weaning were included as covariates in the analysis of calf birth and weaning BW where significant ($p < 0.05$). Differences in calf sex ratio between treatments were analysed using a 2 x 2 contingency table and χ^2 test.

Weekly data (DMI, BW and BCS) from GD 168 to 266 (15 observations per animal) were analysed using random coefficients regression (Genstat Version 15.1, Lawes Agricultural Trust, 2012). Models were developed for BW, DMI and BCS that included diet, breed and time (linear and quadratic effects) and their interactions where significant ($p < 0.05$) as fixed factors and animal and animal x week as random factors. Cow BW and BCS at allocation (GD 148) were included as covariates where significant ($p < 0.05$).

Results

Cow performance between gestation days 168 and 266

There were no differences (Table 3) in BW, BCS or age between breeds or diets at allocation at GD 148. On GD 168 (Table 3), crossbred Limousin cows were heavier than Luing cows ($p < 0.001$) and cows fed BG heavier than those fed GS ($p < 0.001$).These differences were still present on GD 266. BW change between GD 168 and 266 was greater for the cows fed BG than GS ($p < 0.001$) and for crossbred Limousin compared to Luing cows ($p < 0.05$). On GD 168, crossbred Limousin cows had greater BCS than Luing cows ($p < 0.01$) and this difference was still present on GD 266 ($p < 0.001$). BCS loss between GD 168 and 266 was greater ($p < 0.05$) for Luing than crossbred Limousin cows. There was no overall effect of diet on BCS. There were no differences in DMI ($p > 0.05$) between breeds or diets.

Calf birth and weaning weights

There were no differences between breeds or diets ($p > 0.05$) in length of pregnancy (Table 4). Calf birth BW (adjusted for calf sex, $p < 0.001$) was greater ($p < 0.001$) for calves born to cows fed BG than GS with no difference between breeds. Calf sex ratio did not differ between treatments (χ^2=6.6, $p > 0.05$). At weaning, calves born to BG-fed cows were heavier than those born to GS-fed cows ($p < 0.01$ after adjustment for weaning age). There was also a tendency for calves born to crossbred Limousin cows to be heavier than those born to Luing cows ($p = 0.056$).

Modelling of cow BW, body conditions score and dry matter intake over time

Cow BW change over the 15 week period was influenced by breed ($p < 0.001$) and week of experiment (linear and quadratic effects, both $p < 0.001$) and there were interactions between diet and both linear and quadratic effects of week ($p < 0.001$). Cow BW at allocation was also included as a covariate ($p < 0.001$). Thus mean weekly BW was best predicted by the following relationship (SE of coefficients in parentheses) which together with observed BW is shown in Fig. 1:

$$\text{BW (kg)} = 647\ (3.6) - 5.1\ (3.1)\ {*}\text{breed} + 8.6\ (0.61)\ {*}\text{week} - 0.31(0.032){*}(\text{week}{*}\text{week}) - 6.2(0.89)\ {*}(\text{diet}{*}\text{week}) + 0.20(0.047)\ {*}(\text{diet}{*}\text{week}{*}\text{week}) \quad (1)$$

where the effect of breed is the change from crossbred Limousin to Luing and for diet the change from BG to GS.

BCS change during the 15 week experimental period was influenced by diet ($p < 0.05$), breed ($p < 0.001$), week of experiment ($p < 0.01$) and the interaction between week of experiment and breed ($p < 0.01$). Both cow BW and BCS at allocation to treatment were ($p < 0.001$) covariates. Thus BCS was best explained by the following relationship (SE of coefficients in parentheses) which is shown in Fig. 2: with observed BCS.

$$\text{BCS} = 3.1(0.04) - 0.27\ (0.051)\ {*}\text{breed} - 0.22\ (0.048)\ {*}\text{diet} - 0.0017\ (0.00051){*}\text{week} - 0.022\ (0.0076)\ {*}(\text{week}{*}\text{breed}) \quad (2)$$

where the effect of breed is the change from Limousin to Luing and for diet the change from BG to GS.

As there were no differences in DMI due to diet or breed DMI was best explained by the following relationship (SE of coefficients in parentheses) which is shown in Fig. 3 with observed DMI:

$$\text{DMI (kg/d)} = 13.6\ (0.43) - 0.14\ (0.026)\ {*}\text{week} \quad (3)$$

Discussion

Metabolisable Energy supply

An initial evaluation of metabolisable energy (ME) supply (AFRC 1993) across the entire experiment was made from the data in Table 3. A one unit decrease in BCS was assumed to be equivalent to 3200 MJ of dietary ME (Wright et al. 1986). Total ME supply (feed plus mobilised tissue) between GD 168 and 266 was calculated to be (MJ ME) 6632, Limousin/BG; 7164, Luing/BG; 7666, Limousin/GS and 8080, Luing/GS. Therefore it appeared that GS supplied more energy than did BG. A possible explanation for the difference between diets was that BG-fed cows were observed to attempt to sort the mixed feed to select brewers grains. The maximum effect of selection upon ME supply was estimated by assuming that all refusals consisted solely of barley straw. Based on 216 records, if refusals contained no brewers grains, the ratio of straw to brewers grains consumed would have been (DM basis) 334, brewers grains: 666 straw instead of the ratio of 206 to 783 in feed offered. Therefore, ME intakes would have increased to 7138 and 7676 MJ for Limousin/BG and Luing/BG respectively or 0.93 and 0.95 of ME intake for GS. It is also possible that brewers grains ME (calculated from feed analysis; 10.8 MJ / kg DM) may have been underestimated compared to that given in UK feed tables (11.5 MJ ME / kg DM; Thomas 2004). However, using this value would only have increased ME intakes for BG to 0.94 and 0.96 of GS for Limousin and Luing cows respectively. Therefore, the BG diet did not supply more ME than the GS diet.

Metabolisable protein supply

The metabolisable protein (MP) supply for the diets fed was therefore calculated according to AFRC (1993). The GS diet supplied approximately 4.5 g MP/MJ ME compared to 6.6 g MP/ MJ ME for BG. This difference was largely due to an increase in digestible undegradable protein (DUP) supply from 1.1 (GS) to 2.8 (BG) g/MJ ME. On both diets, estimated protein supply to the rumen (effective rumen degradable protein, ERDP) was less than requirement and the deficit was greater on GS than BG (0.72 v 0.88 of estimated ERDP requirements respectively). Clearly the main difference between BG and GS was that protein supply both to the rumen microflora (ERDP) and the host animal (MP) was superior on BG and would seem most likely to explain the superior performance on BG.

Effects of diets

There is a general consensus that maternal under-nutrition only impacts calf birth BW negatively in mid to late gestation (Holland and Odde 1992; Greenwood and Cafe 2007;Robinson et al. 2013) and that reductions in birth BW have long term consequences for weaning and slaughter BW and these effects are independent of post-natal nutrition (Robinson et al. 2013). It is also accepted that global (energy) nutrition has a greater impact than protein nutrition (Holland and Odde 1992; Greenwood and Cafe 2007) which is contrary to the results reported here. However, recent studies (Stalker et al. 2006; Martin et al. 2007; Larson et al. 2009; Bohnert et al. 2013; Klein et al. 2014) in which protein supplements were fed to beef cows in mid / late gestation have reported increases in calf birth and / or weaning BW, although in some cases responses were not significant. In these studies protein intakes were increased by feeding a supplement to cows grazing low quality forage and therefore not only protein but also energy intakes would have increased (for example by 1.5-fold; Klein et al. 2014). Therefore responses in cow and calf performance could not be solely attributed to increased protein supply.

Relatively few studies have attempted to modify nutrient intake to beef cows whilst maintaining energy intakes constant. Radunz et al. (2010) compared either maize grain or distillers dark grains with solubles (DDGS) with hay in late gestation diets and both maize and DDGS diets increased calf birth BW. However, energy intakes were increased when maize and DDGS were fed and the response in birth BW was more closely related to increased energy rather than protein intakes. Recently, Gunn et al. (2014) fed a diet containing excess crude protein (mainly in the form of rumen undegradable protein) to beef cows from GD 192 in comparison with a diet supplying the same amount of energy but with no excess crude protein and observed an increase in birth BW from 32 to 37 kg. Although it is difficult to be precise, it is likely that the diet supplied less ME than that required for maintenance and gestation, and therefore as in the current experiment, a response to undegradable protein supply was observed (Gunn et al. 2014) when overall energy supply was less than requirement and cows were mobilising fat (declining BCS). Thus in relation to maternal nutrient supply to the foetus, amino acids would have contributed a greater proportion of total nutrients on the BG diet. In ruminants (Pere 2003), fatty acid uptake by the placenta is low and in contrast, amino acids are both actively transported across the placenta and important oxidative substrates for the foetus. Therefore it is likely that the increases in calf birth BW on diet GS were mediated by utilisation of absorbed amino acids as an energy substrate.

Effects of breed

Luing cattle lost more BCS than crossbred Limousin cows and there were corresponding differences in BW gain / loss. As a result, ME supply (feed adjusted for BW loss) was greater for Luing than crossbred Limousin cows. In part this difference may have arisen from using a common value for the ME equivalent of BCS which assumes both that the composition of mobilised tissue and mobilisation of sub-cutaneous fat was in proportion to other adipose tissue depots were similar between breeds. Wright and Russel (1984) showed that the proportions of fat in different depots did vary with breed and there were differences between breeds in the composition of mobilised tissue. Thus feeding systems for pregnant beef cows that predict the energy value of mobilised tissue from changes in BCS (e.g. NRC 1996) use a variable composition of mobilised tissue for different BCS and BW and / or employ breed dependant values for the energy content of mobilised body tissue (CSIRO 2007). Since there are no data on the composition of mobilised tissue of present beef cow genotypes it is difficult to comment on any differences between breeds. The greater loss in BCS and therefore mobilisation of adipose tissue by Luing cows however did not increase calf birth BW. This may be because fatty acids are not readily transported across the bovine placenta (Pere 2003) and therefore additional fatty acids mobilised by the Luing cows would not have contributed to foetal growth.

Estimation of requirements for beef cows

Current UK calculations of the ME requirements of beef cows require a knowledge of maternal BW and BW change together with stage of pregnancy (AFRC 1993). The system does not correct maternal BW or BW change for the growth of the gravid uterus. The implications of the above approach were examined at GD 182, 218 and 252 using equations 1 to 3. For simplicity calculations are shown only for crossbred Limousin cows fed BG or GS as results were similar for Luing cows. Maternal BW was corrected for conceptus weight according to (NRC 1996) using mean observed calf birth BW and cow BW change (kg/d) was estimated from linear regression of BW upon time for the two weeks before and after each time point. Table 5 shows that partition of maternal BW change into maternal and conceptus components had a large and variable effect on ME requirement particularly when the cow was gaining weight (crossbred Limousin fed BG at GD 182). In contrast, body tissue mobilisation had little effect on requirement as efficiency of use of mobilised tissue energy for conceptus growth is low (0.2, Wright et al. 1986). However, as BW of beef cows is not normally available on farms, Table 5 also shows ME requirements on GD 218 calculated from maternal maintenance and conceptus requirement but using the ME equivalent of BCS change (Wright et al. 1986) and BCS change over the entire experiment adjusted to a daily basis instead of BW change to correct for adipose tissue mobilisation. The bias that changes in BW had on ME requirements particularly on the BG diet were largely removed using this approach and discrepancies between ME supply and requirement were small. Clearly, in the absence of BW data, practical rationing systems for beef cows should be based on BCS rather than BW change.

Conclusion and Recommendations

Replacement of GS with BG improved the performance of beef cows as demonstrated by differences in BW, reduced loss of BCS and greater calf birth and weaning BW. Luing cows mobilised more body tissue, as measured by changes in BCS, than Crossbred Limousin cows. The differences between diets in performance were most likely due to increases in protein supply on diet BG. It is suggested that, when beef cows are fed diets containing large proportions of low quality forage and therefore mobilising adipose tissue, consideration should be given to protein supplementation to supply amino acids to the foetus to improve both foetal energy and protein status.

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Table 1 Component composition (g/kg dry matter) and calculated chemical composition of experimental diets

Diet	Brewers grains	Grass silage
Components (g/kg)		
Barley straw	783	665
Brewers grains	206	
Grass silage		325
Mineral / vitamin mix*	10	10
Composition (g/kg dry matter)		
Dry matter (g/kg)	558	529
Crude protein	68	61
Neutral detergent fibre	779	686
Acid detergent fibre	522	508
Starch	5	0
Water soluble carbohydrates	5	20
Ether extract	36	22
Ash	40	50
ME (MJ/kg DM)†	7.3	8.2

* Mineral / vitamin mix (Norvite, Insch, Aberdeenshire) supplied (mg/kg unless stated otherwise) vitamin A, 500000 international units (IU); Vitamin D 100000 iu; Vitamin E 4000; Fe, 5271; Mn, 5000; Zn, 3600; I, 1000; Co, 90; Cu, 3000; Se, 35.

† ME, Metabolisable Energy

Table 2 Analysed chemical composition of feeding stuffs (g/kg dry matter)

	Barley straw	Grass silage	Brewers grains
Dry matter (g/kg)	841	350	259
Crude protein	20	149	253
Neutral detergent fibre	850	373	551
Acid detergent fibre	593	353	278
Starch			22
Water soluble carbohydrates	6	50	3
Ether extract		35	114
Ash	40	72	40
NCGD*	300		566
ME (MJ/kg dry matter)*	6.5	12.1	10.8
pH		4.3	

*NCGD. Neutral cellulose and gamanase digestibility; ME, Metabolisable Energy estimated from analysed composition (Thomas 2004).

Table 3 Body weight (BW) and body condition score (BCS) of crossbred Limousin or Luing cows fed diets containing barley straw and brewers grains (BG) or barley straw and grass silage (GS) at allocation, start and end of experiment and mean dry matter intakes (DMI) throughout experiment.

Breed	Limousin		Luing			p-value		
Diet	BG	GS	BG	GS	SEM	Diet	Breed	Interaction
At allocation (GD 148)								
age (years)	3.9	5.1	6.9	5.7	0.71	ns	ns	ns
BW (kg)	598	628	585	603	29.6	ns	ns	ns
BCS	2.9	3.1	2.5	2.8	0.20	ns	ns	ns
At start (GD 168)								ns
BW (kg) †	615	591	603	598	3.6	***	***	ns
BCS†‡	3.1	2.8	2.9	2.7	0.08	ns	**	ns
At end (GD 266)								ns
BW (kg) †	658	609	641	587	7.1	**	***	ns
BCS †‡	3.0	2.8	2.7	2.4	0.09	ns	***	ns
Difference (GD 266 – GD 168)								
BW (kg) †	43	17	37	-12	6.3	***	*	ns
BCS†	-0.15	-0.01	-0.27	-0.29	0.092	ns	*	ns
								ns
Dry matter intake kg/d)	8.6	9.5	8.8	8.9	0.46	ns	ns	ns

SEM, standard error of the mean; *, $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

† BW at allocation a significant covariate ($p < 0.05$)

‡ BCS at allocation a significant covariate ($p < 0.05$)

Table 4 Pregnancy length together with calf birth and weaning body weight (BW) for crossbred Limousin and Luing cows when fed diets, between gestation days 168 and 266, containing barley straw and brewers grains (BG) or barley straw and grass silage (GS).

Breed	Limousin		Luing			p-value		
Diet	BG	GS	BG	GS	SEM	Diet	Breed	Interaction
Pregnancy length (days)	278	281	279	276	1.13	ns	ns	ns
Calf BW (kg) ‡								ns
birth	44	36	44	41	1.06	***	ns	ns
weaning	320	287	286	265	11.3	**	†	ns
Calf sex (proportion male)	0.63	0.77	0.22	0.50		ns	ns	ns

SEM, standard error of the mean; † $p < 0.10$; *, $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

‡ Calf birth BW adjusted for sex ($p < 0.001$); calf weaning BW adjusted for age at weaning ($p = 0.09$).

Table 5 Estimated Metabolisable Energy (ME) requirement and supply for crossbred Limousin cows fed diets of either barley straw and brewers grain (BG) or barley straw and grass silage (GS). ME requirements were calculated using mean predicted BW and BCS (see Results, equations 1 and 2) and ME supply using mean predicted dry matter intake (see Results, equation 3).

	BG			GS		
Gestation day	182	218	252	182	218	252
Body weight (BW, kg)	627	653	663	601	606	606
Adjusted BW (kg)[†]	608	621	613	585	580	565
Adjusted BW change (kg /day)	0.7	0.1	-0.6	0.0	-0.3	-0.6
ME (MJ/day)						
Requirement	118	82	85	65	68	76
Supply	75	75	73	75	72	68
Supply - requirement	-43	-7	-12	+10	+4	+8
Condition score change		-0.15			-0.01	
Equivalent ME		5			0.3	
ME requirement[‡]		70			68	

[†]Adjusted BW: BW less calculated conceptus weight.

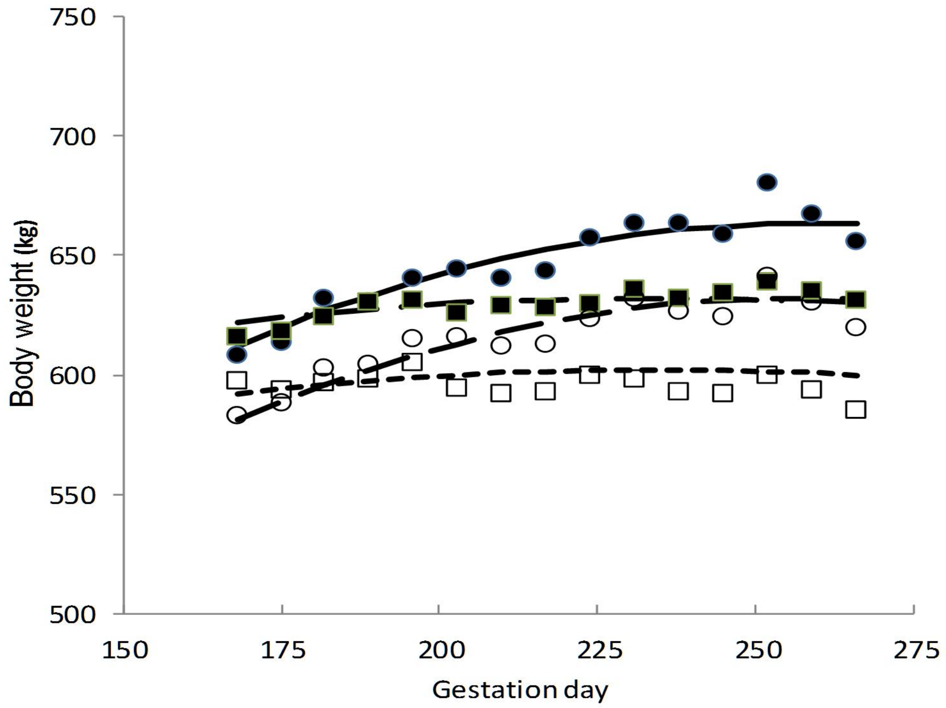
[‡]ME (maintenance) + ME (conceptus) – ME equivalent from condition score change ((Wright et al. 1986).

Fig. 1 Changes in body weight of crossbred Limousin (solid symbols) and Luing cows (open symbols) between gestation days 168 and 266 when fed diets containing barley straw and brewers grains (BG, round symbols) or barley straw and grass silage (GS. square symbols). Symbols denote actual mean observations whilst lines denote fitted values (crossbred Limousin / BG, solid line; crossbred Limousin / GS, dot-dash line; Luing / BG, long dashes; Luing / GS, short dashes).

Fig. 2 Changes in body condition score of crossbred Limousin (solid symbols) and Luing cows (open symbols) between gestation days 168 and 266 when fed diets containing barley straw and brewers grains (BG, round symbols) or barley straw and grass silage (GS. square symbols). Symbols denote actual mean observations whilst lines denote fitted values (crossbred Limousin / BG, solid line; crossbred Limousin / GS, dot-dash line; Luing / BG, long dashes; Luing / GS, short dashes).

Fig. 3 Changes in dry matter intakes of crossbred Limousin and Luing cows between gestation days 168 and 266 when fed diets containing barley straw / brewers grains or barley straw / grass silage. Mean values (with SE, symbols) are given for all animals together with fitted values (line) as there were no significant differences in dry matter intakes between breeds or diets

Figure 1



750
700
650
600
550
500
Body weight (kg)
150
175
200
225
250
275
Gestation day

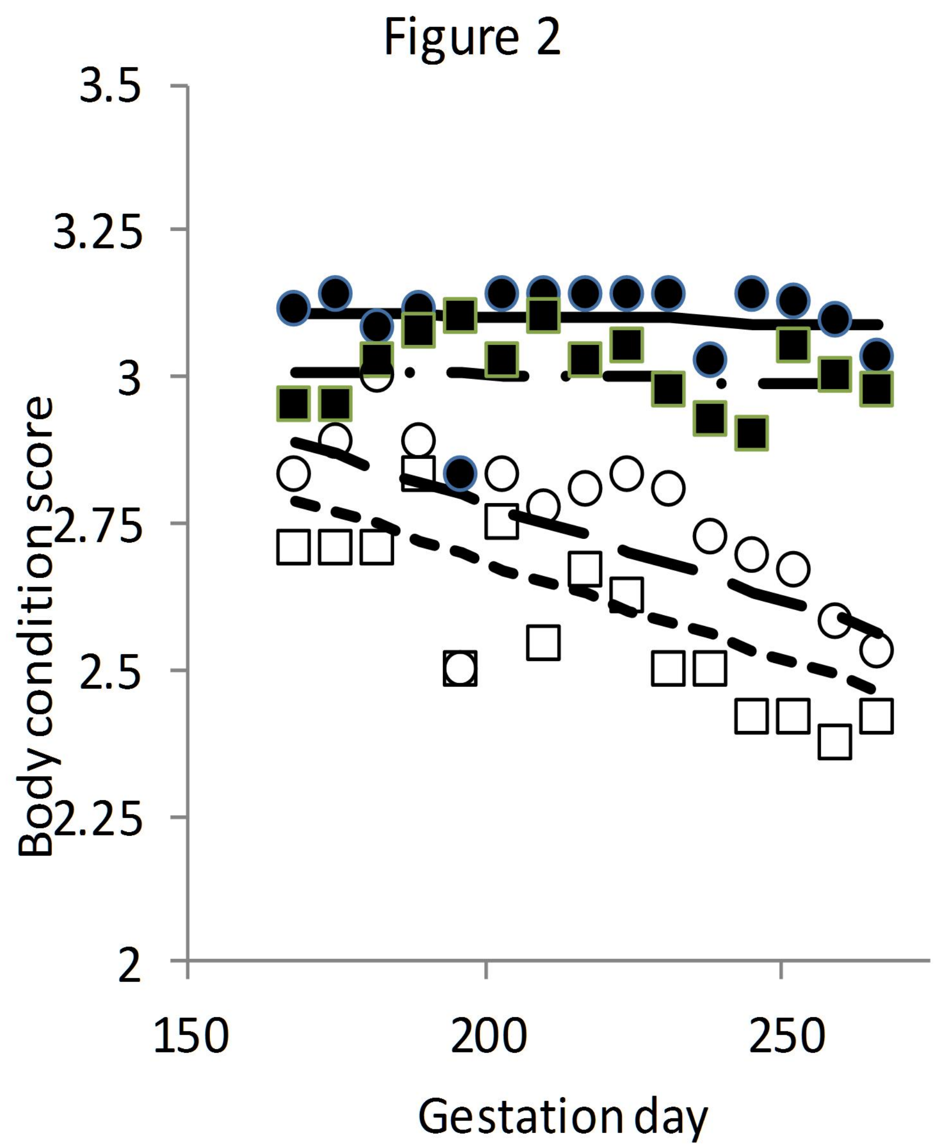
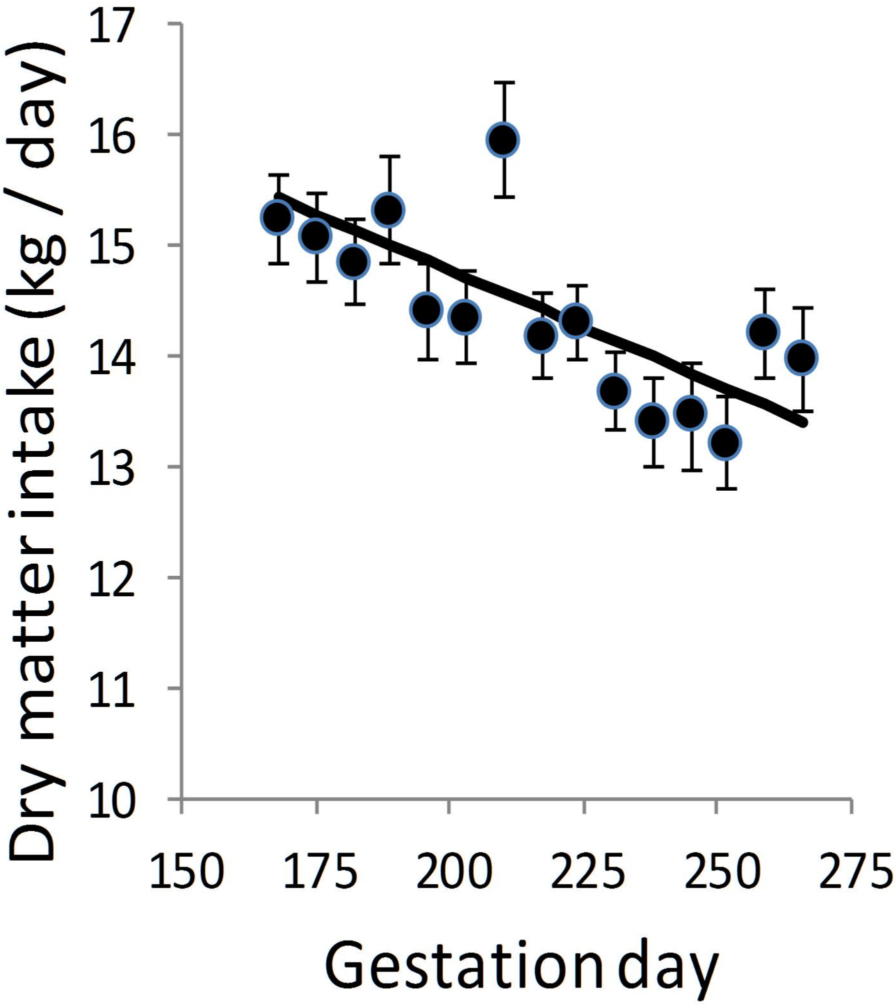


Figure 2
3.5
3.25
3
2.75
2.5
2.25
2
Body condition score
150
200
250
Gestation day

Figure 3



Dry matter intake (kg / day)
17
16
15
14
13
12
11
10
150
175
200
225
250
275
Gestation day